

The Formal Description of Computational Creativity

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This Talk

- Looking at creative systems in general.
- Taking an abstract perspective.
- Considering formal accounts of creative systems.

“The performance of tasks which, if performed by a human, would be deemed creative.”
(Wiggins 2006)

Two common usages of “creative”:

“weak” version

(a) an activity (e.g. painting, musical composition, writing poetry) which is regarded as inherently “creative”

(b) displaying particular skill or artistry or ingenuity

“strong” version

“*creative_w*” vs. “*creative_s*”

A program could be “weakly” creative without being “strongly” creative.

e.g. a music composing program which generates simple and unoriginal melodies.

A program could be “strongly” creative without being “weakly” creative.

e.g. a mathematical theorem generator which displays a high degree of originality and ingenuity.

A program could be both “weakly” and “strongly” creative.

e.g. a poetry writing program which generates subtle, profound and innovative verse.

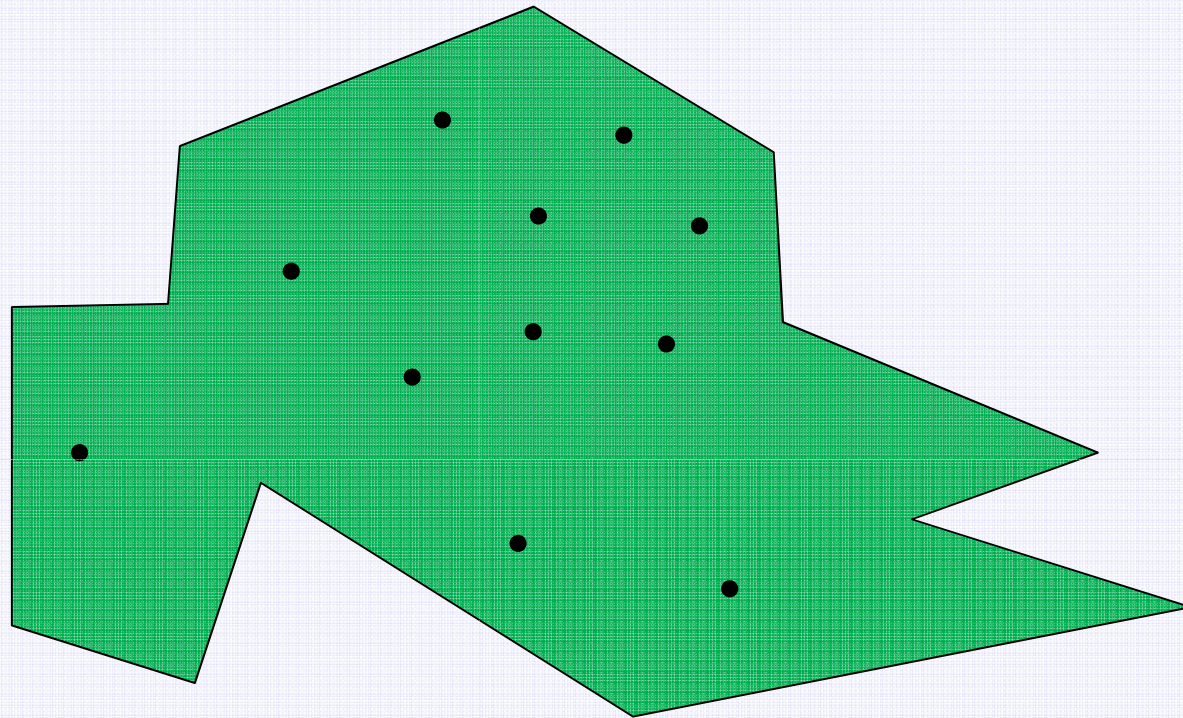
What is distinctive about creative_w systems?

- The program generates (“creates”) some sort of structured artefact (possibly abstract).
- The set of acceptable artefacts is not well-defined.
- The set of acceptable artefacts is very large (maybe infinite).
- Deciding on the acceptability of an artefact depends on factors which are social, cultural, subjective, personal.
- Artefacts vary in how “good” they are (“quality”).
- Quality is also determined subjectively.

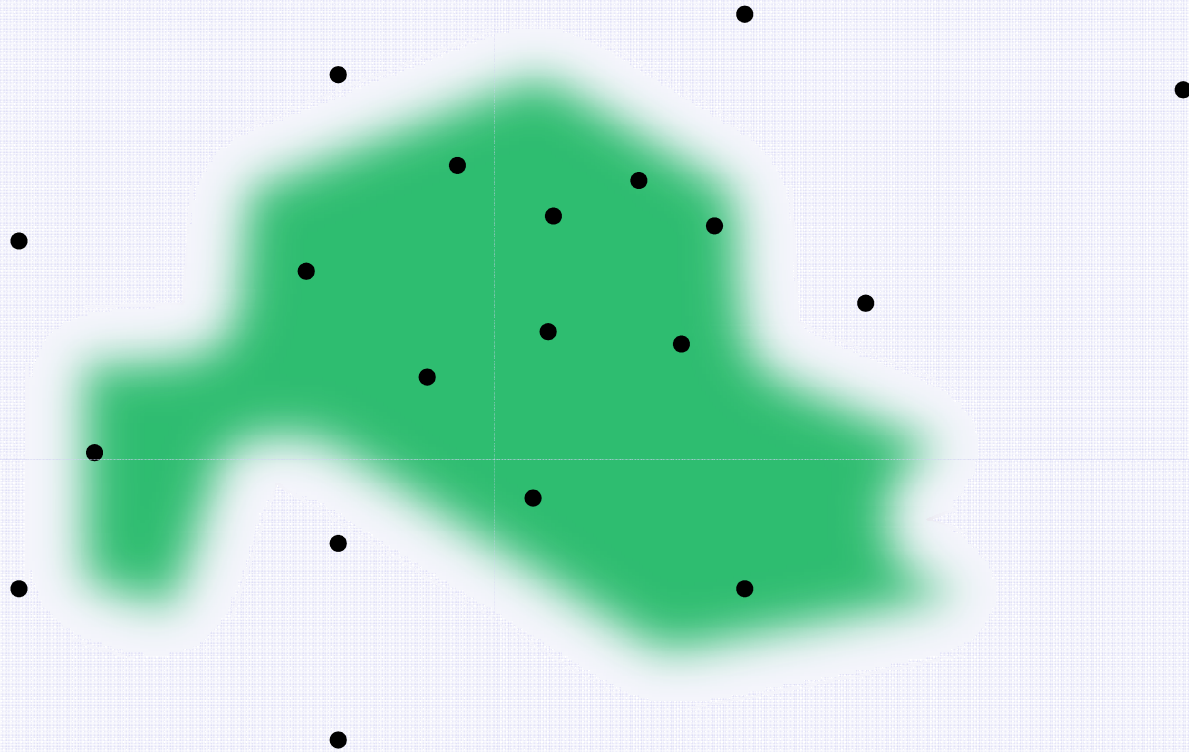
Two “spaces” (sets of items) here (at least):

- possible structures (e.g. sequences of words & punctuation)
- artefacts as defined by rules and conventions (styles, genres, etc.)

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A “search” through some “space” of **possible** structures (e.g. sequences of words, arrays of pixels, etc.) to find **acceptable** artefacts.

The set of acceptable artefacts is the “*conceptual space*”.

How can we characterise this process in more detail?

Boden : types of creative process

Wiggins : creativity as search

Boden (1990 onwards)

Being creative involves producing an idea or artefact which is:

- new
- surprising
- valuable

(Later authors use terms like “concept” or “artefact” to cover Boden’s “idea or artefact”.)

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Boden

A major aspect of creativity is *novelty*.

H-creativity: artefact is novel within history – no one has done this before.

P-creativity: artefact is novel for the creator – given what the creator knew, the artefact is new.

For computational modelling, we are interested in P-creativity.

Boden

Three types of creativity, “distinguished by the types of psychological process that are involved in generating the new idea” :

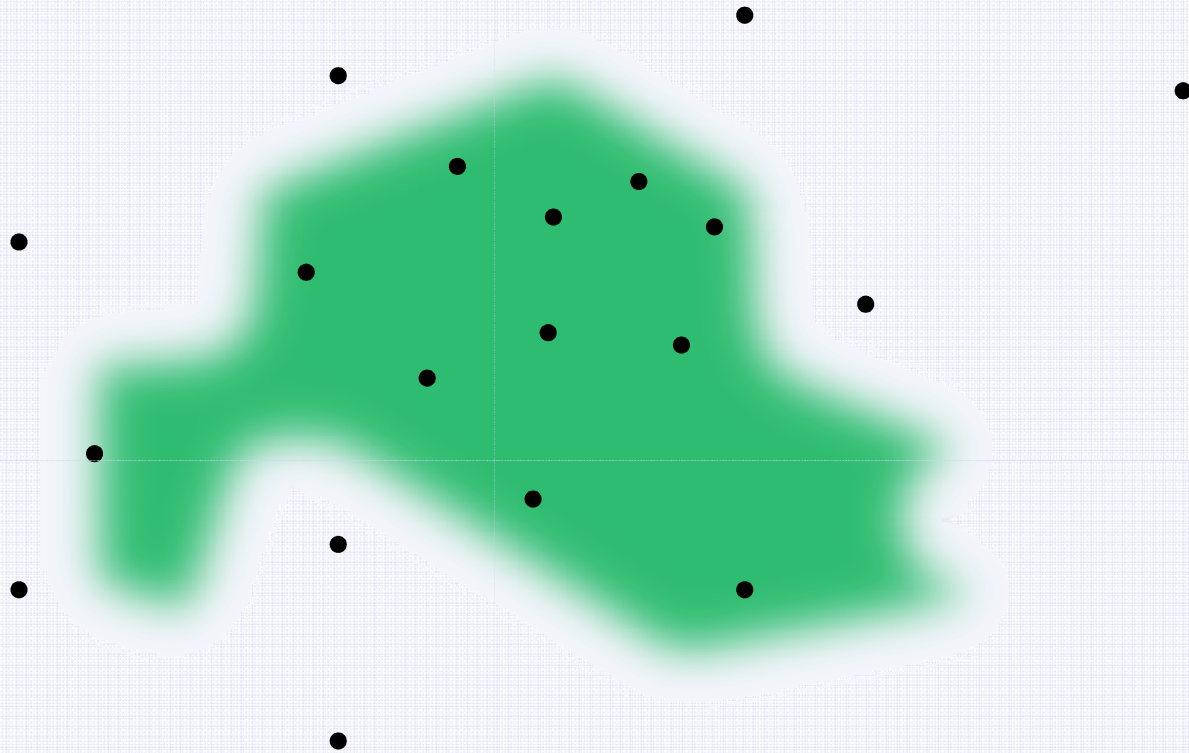
- **Combinational** : “the generation of unfamiliar (and interesting) combinations of familiar ideas”
- **Exploratory** : “existing stylistic rules or conventions are used to generate novel structures”
- **Transformational** : “some deep dimension of the thinking style, or conceptual space, is altered”

Combinational creativity – some examples

“visual collage (in advertisements and MTV videos, for instance); much poetic imagery; all types of analogy (verbal, visual, or musical); and the unexpected juxtapositions of ideas found in political cartoons in newspapers.”
(Boden 2007)



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Exploratory creativity: some examples

Cope's pastiches (by software) of renowned musical styles.

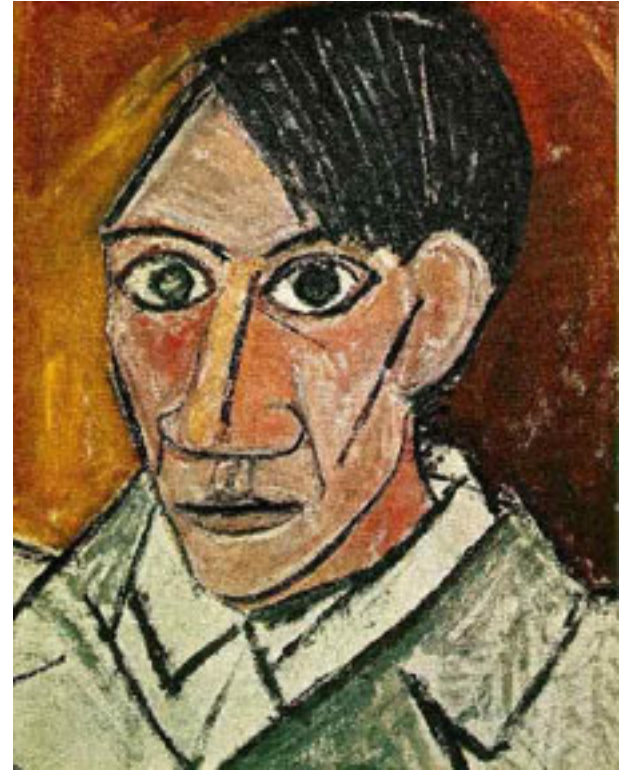
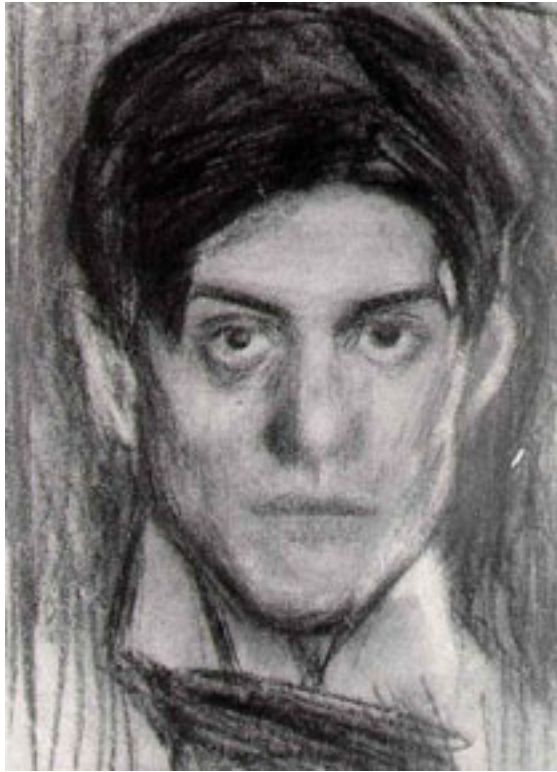
Konig & Eisenberg's program that generates designs of “prairie houses”.



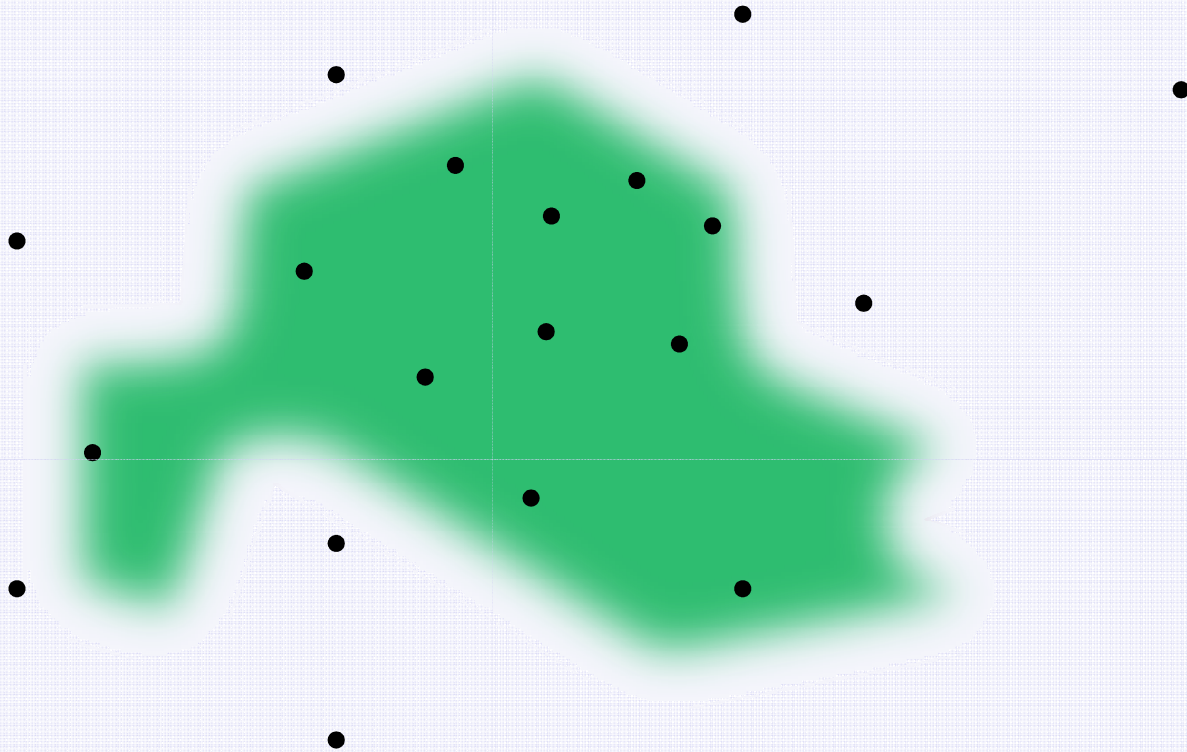
Transformational creativity: some examples

Picasso's early work on cubism

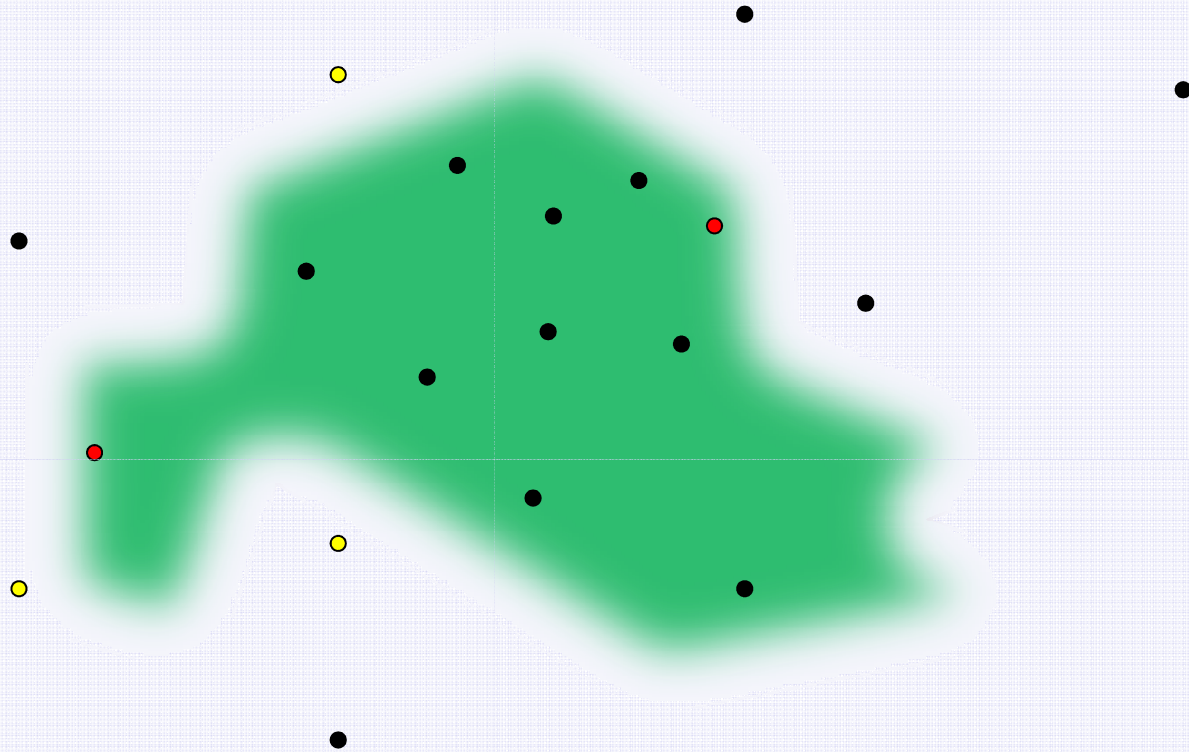
Schoenberg's atonal music



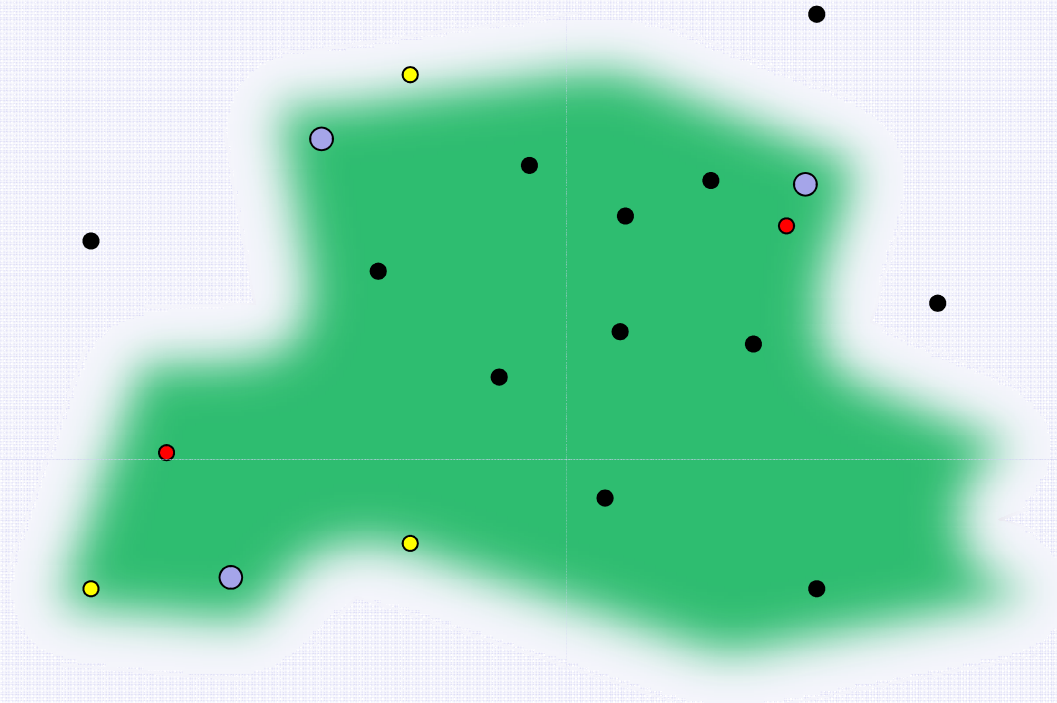
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How can we distinguish (formally) between “combinational” and “exploratory”?

Are they not both controlled by rules (conventions, styles, patterns, etc)?

If transformational creativity allows creations which were not permitted “before” the transformation, how is the transformation permitted?

Would that not just be a further “rule”, and so the new creations were in fact available all the time?

Is transformational creativity the highest form of creativity?

Is that empirically testable?

Wiggins' “Creative Systems Framework”

- A formal definition
- Aimed at capturing Boden's intuitive ideas
- Describes the mechanisms underlying a “creative_w” system
- Includes a search process (for “concepts”)
- Allows the description of various behaviours, including “transformational” creativity

CSF – an exploratory system

Universal set \mathcal{U} – multi-dimensional set of all possible concepts

Function R from \mathcal{U} to $[0,1]$ – defines the “conceptual space”

Function E from \mathcal{U} to $[0,1]$ – defines the “quality” of a concept

Function $T_{R,E}$ from concept-sequences to concept-sequences – the exploration strategy

- ✓ A possible formalisation of Boden's "exploratory creativity".
- ✓ Describes "exploration of a conceptual space", R and T.
- ✓ Distinguishes conceptual space R from universal set \mathcal{U}
- ✓ Distinguishes "being in the conceptual space", R, from "being a valued concept", E.
- ✓ Distinguishes "being in the conceptual space", R, from "being reachable", T.
- ✓ Different agents could have same R but different T

CSF – the metalevel

Express the original R , E and $T_{R,E}$ in some language, \mathcal{L}

Treat \mathcal{L} as a new “universal set”.

Search through expressions in \mathcal{L} in the same way:

- Universal set, \mathcal{L}
- Conceptual space, R_m
- Evaluation measure, E_m
- Processing strategy, T_m



An exploratory system,
but at the metalevel

Object-level “spaces” altered by exploration at the metalevel.

CSF – the metalevel

- ✓ Possible formalisation of Boden's “transformational” creativity
- ✓ Distinguishes “mere exploration” from “space-changing”
- ✓ Explains the “could not be reached” limitation

Some conditions of interest:

Hopeless uninspiration: E does not value anything in U.

Conceptual uninspiration: E does not value anything in the space defined by R.

Generative uninspiration: T does not reach anything in the R-space which is also valued by E.

Aberration: T reaches concepts outside the R-space. These concepts could be:

- All valued by E (“perfect aberration”)
- Some valued by E (“productive aberration”)
- None valued by E (“pointless aberration”)

Summing up

“Creative” is ambiguous between “weak” (doing something artistic, etc) or “strong” (being particularly innovative and successful)

Creative activity can be seen as searching a conceptual space.

Need some definition of the space, some way of exploring, and some way of evaluating.

Transforming the space gives more radical creativity.

Transformation can be modelled as exploration at a metalevel.

The Creative Mind : myths and mechanisms

Margaret A. Boden (2004)

(2nd Edition) . Routledge : London/New York

(First edition published 1990).

Searching for computational creativity

Geraint A. Wiggins (2006)

New Generation Computing 24 (3) 209-222.

A preliminary framework for description, analysis and comparison of creative systems

Geraint A. Wiggins (2006)

Knowledge-Based Systems 19, 449-458.